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ABSTRACT

Beginning in 1985, Apple Computer, Inc. and several school districts began a collaboration to examine the impact of intensive computer use on instruction and learning in K-12 classrooms. This paper follows the development of a Macintosh II-based management and retrieval system for text data undertaken to store and retrieve oral reflections of teacher participants in the Apple Classrooms of Tomorrow (ACOT) project. The effort was conceived as an open-ended and multiple-year inquiry that had to remain entirely flexible to meet researchers' evolving questions. A text-retrieval and analysis system developed earlier by the same team on a minicomputer and required the employment of a full-time programmer. The current effort, conceived specifically for use on a personal computer, is an attempt to keep the entire process in the hands of the research team. Although a highly efficient data management and retrieval system evolved, the data set is developing proportions that challenge state-of-the art personal computer technology. Suggestions about future directions for both the management and analysis of large qualitative data are made. Five appendixes making up about half the document are included. Appendix A contains reporting instructions and examples for the participating teachers; Appendixes B, C, and D contain tape document forms; and theme and category definitions are presented in Appendix E. (Contains 22 references.) (Author/ALF)

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Desktop Social Science: Coming of Age

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Apple Classrooms of Tomorrow℠ (ACOT℠)
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Abstract

Beginning in 1985, Apple Computer, Inc. and several school districts began a collaboration to examine the impact of intensive computer use on instruction and learning in K-12 classrooms. This program was called Apple Classrooms of Tomorrow (ACOT). The initial guiding question was simply put: What happens when teachers and students have constant access to technology?

This deceptively simple question led to many studies that used fine-grained, qualitative data gathering procedures that resulted in prodigious data sets. As with many qualitative studies, the sheer magnitude of narrative data can inhibit systematic analysis and defeat attempts at succinct reporting.

This paper follows the development of a Macintosh II-based management and retrieval system for text data undertaken to store and retrieve oral reflections of teacher participants in the ACOT project. The effort was conceived as an open-ended and multiple-year inquiry that had to remain entirely flexible to meet researchers' evolving questions.

The authors' previous development of a text-retrieval and analysis system was based on a minicomputer and required the employment of a full-time programmer. The current effort, conceived specifically for use on a personal computer, is an attempt to keep the entire process in the hands of the research team. Although a highly efficient data management and retrieval system evolved, the data set is developing proportions that challenge state-of-the-art personal computer technology. Suggestions about future directions for both the management and analysis of large qualitative data are made.

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the ACOT project who are on the line every day, facing full classes, district mandates, and traditional measures. They still manage to discover, grow, laugh, and find the time to share their experiences with us.

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Overview

Problem Statement

Beginning in 1985, Apple Computer, Inc. and several school districts began a collaboration to examine the impact of intensive computer use on instruction and learning in K-12 classrooms. This program was called Apple Classrooms of Tomorrow (ACOT). The initial guiding question was simply put: What happens when teachers and students have constant access to technology?

The effort to describe the processes and outcomes of students and teachers in these classes was, and continues to be, undertaken by a number of independent researchers (e.g., Baker, Herman & Gearhart, 1989; Damarin & Bohren, 1987; Fisher, 1988; Herman, 1988; Hiebert, 1987; Phelan, 1988, 1989; Levine, 1988; Ross, Smith, Morrison & Erikson, 1989; Tierney, 1987, 1988). But we also wanted to discover the meaning teachers as participants assigned to their actions in these radically altered environments, and we wanted to monitor changes in those meanings over time.

In this respect, we were attending to the thinking of Berger and Luckmann (1967), recognizing that more than "casual obeisance . . . be paid to the 'human factor behind the uncovered structural data" (p. 186). To capture this "human factor," teachers were asked to document their experiences in two ways: to produce individual audiotape logs of their reflections on a regular basis; and to send collectively written accounts of weekly events to other participants at other sites in the program via AppleLink, Apple Computer's corporate networking system. These two sources, we believed, would provide rich perspectives on events at the sites and the teachers' personal observations and feelings about those events, and they did (e.g., Dwyer, Ringstaff & Sandholtz, 1990; Sandholtz, Ringstaff & Dwyer, 1990).

Previous experience with studies of this nature, whether they were longitudinal (Smith & Dwyer, 1979; Smith, Dwyer, Prunty & Kleine, 1988) comparative, multisite (Dwyer, 1986) or both (Dwyer, 1981), forewarned us that the quantity of our data would grow geometrically as teachers were added to the project and as they became comfortable submitting data. In our earliest efforts, we explored indexing and cross-referencing data using color coded file folders in an effort to organize and sort data; later, key sort cards were

attempted. But it was our recent study of school principals (Dwyer, 1986) that forced us to look to computers for data management and retrieval. Field procedures in that study across five sites resulted in the collection of over 7500, single spaced, typed pages of field notes and hundreds of pages of interview transcriptions (Dwyer, 1981).

At that time—1984-85, it was common to reduce text data by coding; to store those codes electronically; and to analyze results on mainframes, minis, and in a few instances with personal computers. Our attempt was unusual in that we were attempting to maintain the text data as text, to avoid the reductive step. We were successful, using a Hewlett Packard 3000 mini computer to store, sort, and retrieve text data. It was also a process that required the full-time employment of a programmer. We would have to communicate our desires to the programmer, hope she understood, wait for her to translate our wishes into batch instructions, and then go home for the night to await the results. The very serious delimiter at that time was that databases, once built, were unchangeable. If we made a mistake in structuring the database, there would be no way to add to it or correct the oversight later.

In the current study of teachers' views of their experiences in technology-intensive environments, we set out with the intention of using state-of-the-art personal computers for the same purposes. Only this time, the aim was to keep the entire process in our own hands, making the analysis, retrieval, and use of the data a more personal and interactive process. We also employed a new software release, *Double Helix*, which uniquely (at that time) offered the flexibility to modify categories and the database structure as our understanding of the data emerged. For "grounded theory" advocates, this was an essential feature (Glaser & Strauss, 1967).

This paper reports on the experience and progress of our efforts. Although we were successful at building an efficient data management and retrieval tool that proved useful for the generation of narrative reports, the sheer quantity of our data pushed the limits of the hardware and software at every turn. As text entries neared 14,000 in number, we found it increasingly difficult to maintain a sense of what exactly the database contained. Better tools for grasping overarching themes and patterns in the data are needed to fully utilize large qualitative data sets. We conclude with projections of efforts we will take in the following year to explore such tools.

Settings

The ACOT schools represent the diverse populations and conditions found in contemporary public schooling. Each of these sites began with one classroom in the fall of 1986, adding classrooms, staff, and students in subsequent years. Table 1 summarizes the status of each site in the spring of 1989.

Site	Grades	Teachers	Students	Community/SES
1	1-4	8	180	Suburban/High
2	5-6	7	180	Rural/Middle
3	4-6	4	90	Inner-City/Low
4	4 & Sp. Ed.	4	80	Suburban-Urban/Low-Middle
5	9-12	9	120	Urban/Low-Middle

Table 1: Site Descriptors

In each of these settings, students and teachers have constant access to interactive technologies. The elementary classes are equipped with Apple® IIe, IIGS, and Macintosh® computers. The high school is an all Macintosh installation. In addition to the computers, classrooms are equipped with printers, scanners, laserdisk and videotape players, modems, CD Rom drives, and hundreds of software titles.

The technology is used as a tool to support learning across the curriculum. No attempt is made to replace existing instructional technologies with computers. By design, the classrooms are true multimedia environments where students and teachers use textbooks, workbooks, manipulative math materials, white boards, crayons, paper, glue, overhead projectors, televisions, pianos, etc. as well as computers. The operating principle is to use the media that best supports the learning goal.

Development of a Data Management and Retrieval System

The Data

Teachers at the five 1986 ACOT sites agreed to provide certain data to Apple on an ongoing basis. These data include teachers' audiotape journals

and weekly reports sent via an electronic mail network. In the audiotape journals, teachers record their personal observations of events in their classrooms and their reflections on those events, producing on the average two 60-minute tapes per month. Rather than asking teachers to comment on any particular aspect of their teaching, instructions about content on the tapes are purposefully left vague, leaving teachers free to report what is most salient at the time to each of them. (See Appendix A—Directions to Teachers about Audiotapes.) These tapes are understood by the teachers to be research data, listened to and indexed by research staff. Since these journals are treated confidentially, teachers often take the opportunity to vent their frustrations and share their triumphs, giving the tapes an emotionally charged quality.

Weekly reports communicate major events and developments in a written summary that is electronically distributed among all project participants via Apple Computer's corporate networking system (AppleLink). Again, the content of the reports is left to the determination of the teachers at each site. In contrast to the audiotape data, weekly reports are immediately available to an audience which includes administrative staff and teaching colleagues as well as researchers. Because these reports are publicly aired to everyone connected with the project, they tend to be more self-conscious than the personal, frequently introspective reports contained in the audiotape journals.

The differences between the audiotape data and the weekly reports are evident when the same event is commented upon by a teacher in both an audiotape journal and in a weekly report. For example, when reflecting on a researcher's site visit, a teacher wrote in the weekly report:

> We finished the video project with Bill Hunter last Friday. Despite the presence of the camera, we found it to be a most rewarding experience. We were able to conduct regular classes without even noticing that he was around. Of course the students are old hands at observation and took this one in stride. We also appreciate his encouragement. (Weekly link, April 21, 1988)

In contrast, the teachers' more personal observations about the same event were communicated in his audiotape journal:

> [Bill Hunter] is being very unobtrusive. So far none of the kids are mugging for the camera: it's been better than I hoped for or expected. (Audiotape, April 11, 1988)

> Bill Hunter is still filming. He is the most unobtrusive observer we've ever had, but the kids are beginning to act a little strange. It may just be spring fever, which other teachers are reporting too. But what with one thing and another we've really had a lot of observations lately. Fran and I tend to think it's having an effect on the kids' behavior. (Audiotape April 12, 1988)

Together, then, these two sources of data provide interesting contrasts on events at the sites.

The Design and Evolution of the Database

During the first year of data collection, we decided to design a system to store, manage, and retrieve the increasingly large amounts of data generated by the ACOT sites. We chose *Double Helix*, a relational database, as the software tool primarily because it was the most advanced program available at the time. Another advantage to *Double Helix* was the ease with which it allowed users to make on-going changes in the design and organization of databases. In *Double Helix*, data can be entered by multiple users producing independent files that can later be accumulated into a master database.

Since Double Helix is an application that allows the user to tailor individually specified databases, the first task was to create a template, the form on which data are entered. The original template, shown in Appendix B, was designed simply to allow for the retrieval of audiotape data by site, by teacher, and by date. This form was very basic, allowing for the entry of source descriptors and the transcription of a portion of the teachers' oral or written report. Since directions for the audiotapes were purposefully left open-ended, a major focus at this stage was to determine the topics teachers commonly discussed in their personal reflections.

After several months of entering and reading what we would come to call "episodes," we began to generate a short list of frequently addressed content-specific categories by which the data could be organized. As Appendix C illustrates, the second-generation template allowed researchers to index the data according to where the episode took place—its context, and who was involved—the participants. Researchers could also indicate if the data referred to hardware and/or software, and if the tone of the data was positive, negative, or neutral. If the data seemed especially significant, researchers

could index the episode as a "key story." When the data seemed to call for some sort of further action on the part of ACOT staff members (e.g., a request for assistance or training), it could be identified as such. The "aside" box allowed indexers to record hunches, insights, and emotional reactions as they were indexing the data. Finally, the question, "What is this episode about?" could be answered by filling in the appropriate categories under "theme." Recurrent themes identified at that time included instruction, management, achievement, growth, and ethos. At that time, three analysts worked with the data and met regularly to discuss categories and build a shared understanding of the definitions of those categories.

By the second year of the project, it became quite clear that, due to the sheer number of audiotapes and weekly links being generated, additional researchers would have to be trained to assist in the process of transcribing and indexing data. It was during this second year that the original template was drastically altered to more closely resemble the current template shown in Appendix D.

The decision to change the template was based on numerous factors. First, up until that time, only audiotapes had been entered into the database. Since the template had been designed without carefully examining the weekly reports, researchers who first attempted to categorize these data using the existing indexing categories suddenly found themselves at a loss. Weekly reports differed from audiotapes not only in their emotional overtones, but also in their content. The themes that at first seemed sufficient to capture the essence of the audiotapes did not meet the needs of those attempting to index this second data source. For example, while few teachers mentioned their school district in audiotapes, incidents discussed in weekly reports were sometimes at the district level. Similarly, weekly reports often mentioned site coordinators, researchers, as well as ACOT staff members. Since these individuals were not usually mentioned in audiotapes, there was no way to index their inclusion in the data. Thus, the template was changed when additional subcategories such as "district" and "coordinator" were added to major categories such as Context and Participant.

Second, as more data were analyzed, it became clear that the thematic subcategories in this early template were too broad to be useful for detailed analysis. The original theme "Instruction," for example, could be used to refer to the process of preparing for instruction, to what was actually going on in

the classroom, to what the teacher thought about the lesson after it was conducted, or even to after-school tutoring. Similarly, "Growth" could refer to student motivation, to self-esteem, to attitudes toward school, or any number of other variables. Since, by the second year of the project, the amount of data was growing steadily, the decision was made to further refine, and define, major categories and subcategories to ease data retrieval and analysis.

Third, preliminary attempts to analyze indexed data in *Data Desk*, a software package with graphing and statistical capabilities, pointed to another problem with the original template. In many instances, episodes referred to multiple participants, contexts, or themes simultaneously. For example, one episode might refer to a teacher, a student, a parent, as well as an administrator. Since no standard way of entering multiple subcategories had been decided upon, the subcategories for teacher (T), student (S), parent (P), and administrator (A) could be entered in numerous ways—TSPA, TPAS, APST, and so on. Unfortunately, when the data were read by *Data Desk*, each different combination was considered a different variable, making the data impossible to analyze. To eliminate this problem, the new template was designed to allow each subcategory to have its own entry field.

The template currently being used was developed over the course of several years and went through seven iterations before taking its present form. As Appendix D illustrates, the template being used now consists of 47 different fields, representing 47 different types of data.

Each episode is indexed according to the site from which it originated, and the name of the sender or speaker is entered. The researcher responsible for indexing the material is identified by initials, and the date of the origin of the information is indicated. The data types indicated include Weekly Links (WL), links from ACOT to the sites (AL), Audio Tapes (AT), and Site Links (SL), which are communications between sites or from a site to the ACOT office. Videotaped material (VT) has not been indexed into the database, though provision was made in its design for this capability.

Audiotapes are identified in the database by a three-symbol number: a number representing the site, the number identifying the teacher at the site, and the number of the tape in the sequence for a given school year of data. Similarly, each link communication is identified by a seven-digit number, which is automatically generated when the link is sent. Additionally,

audiotape data is identified by the tape side and number on the tape counter at which a given episode begins. This system allows the retrieval of the original tape recording or electronic link from a data archive.

After each episode is coded with the information identifying its source, the data are indexed according to thirteen major categories of information. While many of these categories are found on the original template, some new categories appear, such as "Outcomes," "Attitude" and "Project Administration." Many new subcategories have been added, allowing for a more refined analysis than was possible using the earlier templates. For complete definitions and examples of categories and subcategories, see Appendix E.

Since earlier work with the database demonstrated that episodes generally fall into more than one subcategory simultaneously, data indexers are allowed to categorize the data using up to three different subcategories. In addition, when a subcategory cannot be chosen because there is no appropriate index, indexers can enter a word or phrase in the "long box" located at the end of each major category. For example, "participants" may occasionally include parents or administrators, but these are not sufficiently frequent to justify an index symbol in the limited format of the template. The indexing staff developed and now utilize a common list of such descriptors for each category. This common list will be used in designing further iterations of the template. Thus, the indexing system continues to evolve in the best "constant comparison" mode of Glaser and Strauss (1967).

The current version of the template also contains a "Key Word" box. This feature will allow other researchers interested in secondary analysis the opportunity to build their own indexing system as they interact with the data. Their personal key words can then be used as a means to retrieve the subsets of data in which they are interested.

Data Entry and Management

At the beginning of data collection, teachers were somewhat reluctant to complete the audiotapes, and telecommunications were usually brief and infrequent. The need for a management system to keep track of incoming data became apparent during the second year of the project, when teachers

became more comfortable with the process of completing audiotapes and weekly reports.

Audiotapes from each site are mailed to the audiotape team leader, who logs their arrival and distributes the tapes to the indexers. After the tapes are transcribed and indexed, they are archived. The first three years of link data were typed verbatim into the database from existing hard copies. Starting in 1988, electronically communicated data have been sent directly over AppleLink to the leader of the link team for indexing. In this way, the data can be downloaded as electronic files, which can be directly copied into the database at a later time, without the laborious typing.

Both the teacher audiotapes and the electronically communicated weekly reports are monitored by graduate students who digest the source information into discrete episodes and index them according to content. These indexers work independently, each on their own copy of the database template. Data from individual indexers are eventually merged to form one complete master database.

During the first five years of the ACOT project, over 300 audiotapes and thousands of weekly reports have been generated, representing approximately 3200 single-spaced pages of prose. The complete database includes approximately 14,000 episodes. As the quantity of data increased over the five years of the project, concerns about the reliability of data entry became paramount.

Data Quality Control

Unlike many research projects that attempt to reduce qualitative data to quantifiable codes or symbols, we decided at the outset of this project that, in addition to the indexing system described above, the database would contain the actual text information generated in the weekly reports and audiotapes. Similar to the index or the table of contents of a book, we wanted our indexing system to direct researchers to episodes illustrating various areas of interest, places where the textual data itself could be studied.

We wanted our indexing system to provide reliable pointers to this large body of verbal, descriptive data. Since the quantity of data was increasing and the number of our data indexers rose from two to nine, we became concerned about quality control in the indexing process. We increased our

effort to define and delineate the indexing categories and wrote a detailed manual that contained definitions of categories and instructions for data entry. We also made a decision to hold regular meetings to allow indexers to discuss and compare their work in an effort to arrive at common interpretations of data and data categories. These steps reduced the degree of inference of the categories and contributed to more accurate indexing in the long run.

To assess the reliability of the indexing process, one of the researchers conducted a detailed analysis of inter-rater reliability (Keirns, 1990). The inter-rater reliability among nine research indexers was computed on three sample episodes using a formula suggested by Miles & Huberman (1984, p. 63):

number of agreements / number of agreements + number of disagreements

Analysis was made of the agreements among the staff in the selection of each index symbol in the thirteen major categories which are indexed in the database. Agreement was computed on the selection of an index as *either* present or not present. Agreements for each category were averaged and a total overall average of agreements for each episode was computed, yielding results of 89%, 91%, and 86% respectively. These reliability figures are within the range suggested as satisfactory by Miles and Huberman (1984) for groups of field workers dealing with similar data, and reflect the effect of considering pooled ratings described by Thorndike and Hagen (1986, pp. 460-461).

Certain changes were also made within the database itself to increase both the speed and accuracy of data entry.* *Double Helix* allows data fields to be "validated." When a field is validated, the software will prevent indexers from entering the wrong information into a field. For example, if someone tried to type their initials into the "date" field, the computer would beep and refuse to accept the entry. A similar response would occur if someone were to

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* At the beginning of this project, indexers using the database were trained for two days in the use of *Double Helix*. During the first year of the project, all design changes in the database were accomplished using the knowledge gained from this brief training. However, as the database became more sophisticated, it became necessary to hire an expert in *Double Helix* to optimize the database's performance.

accidentally misspell an entry in name fields, for example, "site," "sender," or "indexer."

Double Helix also allows values in certain field to be automatically carried to the next record so the same information will not have to be retyped. In our database, these "keep values" included such information as the site, sender, indexer, date, and tape side and foot, since this information was often repeated in numerous episodes. Unfortunately, while "keep values" saved time, they often led to errors in data entry. Since transcribing and indexing data can easily become monotonous, indexers would sometimes forget to change the values when necessary, resulting in incorrect dates, senders, sites, or tape numbers. Usually, these errors were not recognized until long after the data were loaded into the master database.

Despite efforts to ensure accurate data entry, the task of "cleaning" the data became monumental as the database grew. With over 13,000 episodes, and 47 different fields in each episode, there were plenty of opportunities for errors, even with well-trained indexers. Initial attempts to clean the data led to the discovery of thousands of empty "sender" (i.e., teachers who had sent the audiotape or link data) fields—a mishap that occurred when data were merged into the master database using an incorrect loading form. Further examination revealed errors in such variables as dates (particularly around January of each year), in tape numbers, and in the spelling of teachers' names.

Changing the template from the original form into the current form meant the reindexing of thousands of episodes. The process of reindexing and loading this massive quantity of data sometimes led to duplicate (or even triplicate) episodes in the master database, which had to be located and deleted. Inexplicably, missing values have compounded the problem, particularly as we are attempting to analyze trends in the data using the graphing capabilities of *Data Desk, Excel, Systat, and Wingz*. Needless to say, the effort to clean the data is a time-consuming, on-going process.

User Experience

We decided to use the preparation of two of our 1990 AERA papers as testbeds for the efficacy of the database. The first paper looked at a 4-year evolution of teacher beliefs in the project (Dwyer, Ringstaff & Sandholtz,

1990); the second examined classroom management in technology-intensive classrooms (Sandholtz, Ringstaff & Dwyer, 1990).

For the first paper, we used the categories *Instruction , Outcome Changes* , and *Attitude Changes* to delineate a subset of data. We then extracted ("dumped" in *Double Helix* parlance) that data chronologically by teacher. These "dumps" as text files can be read with any Macintosh-based wordprocessor. In this instance, we used *Word 4.0*.

For any teacher we selected, then, we could read a chronological account of their thoughts about the preparation, delivery, and evaluation of instruction; their perspectives about the impact of those instructional approaches on their students; and their reflections on their own changing attitudes about technology and the business of schooling. Because the database contained the weekly links from sites, we could often match public and private accounts of the same instances. Reading and rereading these data led to the conception about instructional evolution put forth in the paper and contrary instances, also contained in the record, allowed the fine tuning of the concept, again rendered in the paper.

As we developed a sense of the story that emerged from the data and an outline accrued, particularly relevant quotes could be electronically cut and pasted into the outline. Prose was then added around the data to focus the reader on issues or to reflect on our interpretations of the data. In a very real sense, the data guided the direction of the report.

A similar process was followed for the writing of the second paper, only in that instance, we selected data using the major category *Instructional Management* and the subcategories *Deportment, Attitude toward Technology,* and *Attitude toward Learning*. From that point we extracted the data using all of the teachers' reports. The result there was an analysis and report based on a multiple-perspective account.

From our experience, the benefits of using the database included the number of ways in which we could view our data. We could organize and retrieve data by grade level, school, individual teacher, administrator, context, etc. As we scanned the data from these differing perspectives, new ideas emerged and old ones became richer or were disproven.

Further, the process was relatively fast. In the instance of the paper on teacher beliefs, hundreds of pages of data episodes were contained in the "dumps." Previous technologies would have allowed these pages to be

photocopied, written upon, cut apart, filed in folders, rearranged, and finally retyped into a coherent article. In this instance, all of the mechanical steps were removed. It still took a great deal of time to read each of the data episodes, but from that point on, the construction of our research reports was a simple matter of electronically selecting data and moving it to appropriate locations in the reports. Speed was not the central issue, here: accessing and using all of the relevant data one has collected, was.

Other benefits included the number of forms of reports we could create that were beneficial in the process of monitoring and validating the data entry process. We could also print a number of forms. For example, to encourage our teachers to continue to contribute audiotapes, we annually print a chronological record of their contributions and send the logs to them. Each teacher's log looks and reads like a diary of their classroom experiences. We also make many presentations of this work. We can tailor the display to suit audiences, particularly making sure that the anonymity of our teachers is reasonably guaranteed. We also found it easy to train new data indexers to use the system and were particularly pleased to find that other researchers, who were interested in conducting secondary analyses of the work, found the system easy to master.

Finally, we felt we were successful in producing a straightforward retrieval system that can be used personally by a researcher. Without the aid of a programmer, the database can be simply searched and the relevant data extracted. It was easy and time efficient to pursue hunches in this manner. Deadends could be quickly identified and abandoned. We want to note that with each of the queries we are reviewing and identifying the relevant episodes out of a set of 14,000! Currently, we are running the database on a Macintosh SE30, Macintosh II, and Macintosh IIx. Each is equipped with at least 40 megabytes of storage and a minimum of 2 megabytes of random access memory. It would not be practical to attempt this kind of work on lesser computers.

The major penalties in the process lie in the database preparation and data entry phase. It still takes time to transcribe tape recordings. Once this is done on a computer, however, those transcripts are far more useful than if committed to paper only. Data still need to be read and indexed. In this respect, the old rule still applies: "garbage in, garbage out." There is no technological stand-in for patience and care in these critical but laborious

phases of the work. We also found that as the database became more complex, a certain degree of user control was lost. Our aspirations, however, were not completely met in this past year's efforts. Those aspirations and the difficulties we encountered are discussed in the next section.

Next Steps

The most serious problems we encountered centered around our hope to develop systems for surveying the content of the database as a whole. As one faces the grim task of identifying and substantiating salient themes contained in 14,000 data episodes, the importance of our wish is clear. We have found in past work that the frequency or number of instances of events, perspectives, behaviors, etc. can be indicative of important themes, patterns, or system regularities in the data. Likewise, the absence of data in categories, where one might expect an abundance, can be an important pointer towards some general understanding of a phenomenon. Therefore the ability to represent our text data in tabular and/or graphical format is paramount.

From this perspective we wanted to be able to display graphically the frequency of data events by category over time. We wanted to be able to compare frequencies across and between subjects, sites, and grade levels. All of these comparisons are possible within the *Double Helix* framework we created. Operationalizing that capacity, however, raised a number of issues.

First, when the database was "posted," a process that establishes the necessary relations to draw our comparisons, the size of the database expanded phenomenally. Each of the 14,000 text data episodes is tagged with 47 individual pieces of information. The posted database, then, resulted in a 120 megabyte file that contained almost half a million records. Processing that amount of data is routine on a mainframe computer, but unimagined on a personal computer of any kind. Again, it is important to keep in mind that we are dealing with full text data and not with numeric codes alone. Querying this number of records has defeated the instantaneous interactivity we hoped to accomplish. In the coming year, we will be using the recently announced Macintosh FX to accomplish our analyses, but for personal computers, the spontaneous analysis environment we hoped to create remains in the distant technological future.

Hardware limitations were not the only ones we encountered. Data analysis packages with the necessary graphical capabilities we need also restrict the number of records one can work with at a time. The most powerful available (*Systat, Data Desk, Excel, Wingz*) limit the user to a total record set of fewer than 30,000, a far cry from the half million needed. This means that analyses must be run on subsets of the data. For example, we can examine all schools for one year at a time, or one school for four years, or individual teachers for their entire history with the project. We anticipate that as personal computer hardware continues to advance, software companies will lift these ceilings. They are artificial and artifacts of a time when no one thought desktop computers would ever be powerful enough to accomplish things for which they are commonly used today.

Problems aside, we believe as do Miles and Huberman (1984) that alternative displays or arrays of qualitative data are key to improving our understanding of complex social settings and interactions. The use of computers in the analysis of qualitative data offers a wide range of new displays and processes for creating those displays. In the coming year, we will pursue the use of color, three-dimensionality, rotation, animation, artificial intelligence, and topography to extend our understanding of the content of our own data. In the process we hope to demonstrate more powerful uses of personal computers for the conduct of social science.

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Today, computers, and computer software are common in most schools. Regardless, teachers and teacher education programs remain uncertain about how to maximize learning in technology-assisted environments. To realize the potential of these "miracle machines," we must understand their effects on curriculum, instruction, learning, your students, and yourselves.

To increase our understanding, we assembled a database that captured your broad experiences over the past years. Now, thanks to your dedication and sensitive insights, we can peer "through the looking glass" at education in classrooms of tomorrow.

During the past years, you talked about the impact of computers on curriculums, lesson preparation, and delivery. You also began to redefine your professional roles. You examined the effects of new teaching approaches on students and on yourselves. And you underlined the significance of a new classroom ecology for management practices.

We want to continue to concentrate on these major themes this year. We encourage you to share with us your challenges, struggles, victories, and insights. We urge you to describe for us the effects this technology has on your position at the forefront of educational change. When you make your tapes, think about impacts that you have seen both on your students and on yourselves.

What to Report

This year, we would like you to focus your comments specifically on four fundamental areas. (All of these are important; the list does not signify any priority.)

Instruction (Content/Curriculum, Delivery, Your Assessment of Effectiveness, Preparation). Computers support new content, and varied approaches to instructional delivery. We're interested in knowing more about how computer saturation affects what you teach and how you teach it. For example, do you offer different content as a result of the computer? And if you do, how do you prepare and deliver that content? After you try something new, how do you feel about its relative effectiveness compared to other ways you've done it before?

Student Outcomes (Attendance, Deportment, Engagement, Innovative Thinking, Productivity, Scores). As supportive colleagues, we'd like to know how you feel about your students' achievements in ACOT. We define achievement liberally. Certainly, test scores represent one measure. But measures of typing speed (e.g. words per minute), productivity changes (e.g. amount of work completed), assessments of "time on task," (e.g. freedom from distraction, changes in attendance), also represent achievement. Please describe freely and honestly ACOT students' achievements.

The UCLA assessment picks up much of this, but not your own perceptions of changes in your students. This is an opportunity to describe with rich anecdotes how kids are changing every day in your classes.

Don't forget to tell us about your own achievements. What makes you proud or frustrated, and how are you growing or changing?

Attitude (Curriculum, Learning, Self, School, Technology). Last year you let us know how important the changes were in both your and students' attitudes. This data may be among the most important that we are uncovering. As you perceive changes in your attitudes or those of individual students toward curriculum, learning,

school, technology, or self (positive or negative changes!), please describe those changes for us.

Management (Discipline & Authority, Environment, Grading, Supplies, Workload). Computer saturated classrooms support many new activities that may challenge "tried and true" classroom management practices. From our perspective, management encompasses more than just classroom control. We'd also like to hear about how the ACOT environment may affect how you manage instruction, including grades, homework, software, and even physical aspects of the classroom (e.g. computer setup). Let us know your experiences in these, and other areas you feel may pertain to the management of instruction.

How to Report

- **If possible, make brief notes.** Sometimes a phrase or two jotted down in a daybook or diary will help you recall the details of an interesting story.

- **Think of a descriptive headline.** Imagine that you were reporting to a newspaper. Give an eyewitness account of the event in your own words. Don't worry about formality.

- **Begin each day with your name, the school, and the date.** That information helps us keep track of data.

- **Focus primarily on instruction, management, or achievement.** Of course if you're just bursting to tell us other exciting things, don't hesitate. We want to hear!

- **Relax, be yourself.** Talk to the recorder as if you were telling a story to a friend.

- **Tell us how you feel.** We care and we're interested. We really do want to know.

• **Make sure the recording is intelligible.** Beware of the pause button. If you choose to use pause, be sure the tape is up to speed before speaking. Occasionally, play the tape to check the recording.

• **Be proud.** As a significant part of our research, your valuable reports contribute substantially to the advancement of the teaching profession.

Examples

1. In the first example, the teacher is beginning a new report, so she includes her name, site, and date. Her description deals mainly with achievement issues. Also, parts of the excerpt describe her related instructional approach. So, when you describe your teaching activities, don't feel that you have to separate everything into instruction, management, and achievement. As you will see, often these categories overlap in a single story.

Marianne Faithful, Mountain ACOT, Monday, October 4. It's 5:00 p.m. Am I bushed. Overall though, today was a pretty good day. This morning we worked on problem-solving skills. We are using the Incredible Laboratory to build monsters for Halloween. The students identify chemicals that control the features of monsters. It's quite sophisticated. In doing this, they came up with a lot of strategies. Some kids are pretty good at figuring out what's going on. Others simply guess. Maybe this shows different levels of development.

One student started by producing a monster with all of the chemicals. Next, he eliminated all but one chemical and identified the physical features it controlled. Using this strategy, he identified all the features quickly and easily. He explained his strategy to other kids who immediately understood his approach and began to use it. Following his advice, they all began to take notes and keep track.

While they worked, I read the manual. They suggested identifying features through a process of "successive elimination." I described this strategy to the group and asked who would like to test the approach. Several of the the kids became very excited about that idea.

This program really does encourage a lot of safe experimentation. It really requires kids to try different strategic approaches.

2. This short example pertains almost exclusively to instruction. Note that since the teacher is not beginning a new tape or day, he does not report that information for this episode. He's already done that earlier.

I wanted to run an experiment to calculate the volume of a soap molecule but the lab was occupied. I decided to produce a video that would let me show the experiment on TV. After I made the show, I used it to teach the experimental procedure.

The video reduced the amount of time required to set up and take down the experiment. As a result, we spent much more time on the important task of calculation and conceptual understanding. This worked out quite well.

3. This touching little episode describes achievement—in this case, "time on task." Since the teacher is beginning a new tape, she reports background information.

Shirley Temple, Valley ACOT, Tuesday October 5. Today, I had an experience that I've never had before—everyone was working on their own. They had a task on AppleWorks that required them to add "-est" extensions to words. Everybody was working merrily away. Janice was sucking her thumb with one hand and typing with the other. It looked so cute that I asked my colleague Trudy to come and see. I wish I could have photographed the look of concentration on their faces. The kids were

just typing away. All you could hear was the tap, tap, tap of the computer keys. It was really wonderful.

4. This example depicts a teacher's frustrating experience managing a new classroom context.

Clark Kent, Gotham City ACOT, Monday October 4. Am I tired. The kids nearly drove me crazy today. They talked continuously. They just didn't listen to anything I had to say. I couldn't seem to keep them concentrating on my lesson. They just wanted to use the computers. Maybe I have to think of new ways to teach this material. Maybe I should talk less and have them work more.

5. These examples describe events that on their own are less interesting. They would be relevant if somehow they were related to instruction, management or achievement.

We had an assembly at 3:00 this afternoon. Several students from the other grades staged a Western. Jeremiah Johnson played the part of the Lone Ranger. Sally Fields played Tonto.

The bus broke down on the way to school today. Some of the kids were quite late. They missed our early morning sing song. The music teacher was upset by the disruption.

Conclusion

In the end, we hope that you have some fun making these tape reports. Collectively, they form a valuable documentary—in fact, the only documentary—of the experiences of ACOT teachers. Thanks for all your exciting thoughts and interesting stories.

Tape Documentation

Site:

Speaker:

Date:

Episode:

APPENDIX B

Tape Documentation Tot'l Eps: 2111

Site:

Speaker:

Listener: Tape # (X,X,X):

Date: Side and Foot:

Episode:

KEY WORDS

Context (C,H,S,O):
Classroom, Home, School, Off-site

Participant (S,T,P,A,U):
Student, Teacher, Parent, Administrator, Visitor

Theme (I,M,A,G,E):
Instruction, Management, Achievement, Growth, Ethos

Referent (H,S,U):
Hardware, Software, User

Tone (NEG, 0, POS):
Negative, Neutral, Positive

Key Story (Y,N):
Yes or No; Is this a story you would want to tell?

Action (Y,N):
Does this episode require follow-up?

Aside:

ENTRY#: 14074

Tape - Link Index

1. Site Code: ME Memphis
2. Sender /Speaker Name: [ ] [ ]
   (Teacher or Staff First Name/Last Name)
3. Listener: SC
   (Analyst's Initials)
4. Date: November 6, 1987
   (Date data was generated)
5. Data Type *(SL,AL,WL,AT,VT,X)*: WL Weekly Link
6. Link To: ALL
   (Primary Receiver of Link)
7. Tape#: *(X,X,X)*:
8. Link#: *(7 Digits)*: 8768543
9. Tape Side & Foot:

Episode:

BULLETIN BOARD ACTIVITIES. Wednesday afternoon our Modem tutors from Memphis State University met at Lester to discuss our bulletin board activities. We believe that the quality of our bulletin board homework is improving. We really should be keeping a log of all the excuses that are given for not doing bulletin board homework. Students are the same; it does not matter if they are doing their homework by candlelight or telecommunications, only the tools and terminology change. Excuses remain. Here are the three best ones for this week: "My telephone cord is too short." "Momma gave my adaptor away." "My Modem messed up and erased all my messages."

Key Words:

computer use,
students, home,
bulletin board

If none of the established codes apply, enter a new code description in the last box (Use this box only for new code descriptions)

10. Context *(C,D,H,P,S,X)*: H
    (Classroom, District, Home, Project, School, N.A.)
11. Participant *(A,C,R,S,T,X)*: A TUTORS
    (ACOT Staff, Coordinator, Researcher, Student, Teacher, N.A.)
12. Student Gender *(M,F,X,MF)*: MF
13. Referent *(H,S,X,HS)*: H
    (Hardware, Software, N.A, Both H & S)
14. Instruction *(C,D,E,P,T,X)*: X
    (Content/Curriculum, Delivery, Evaluation of Instruction, Preparation, Testing, N.A.)
15. Instructional Management *(C,E,G,O,S,W,X)*: X
    (Climate, Environment, Grading, Qty of Student Work, Supplies, Teacher Workload, N.A.)
16. Outcomes: Changes *(A,D,E,I,P,S,X)*: X
    (Attendance, Deportment, Engagement, Innovative Thinking, Productivity, Scores, N.A.)
17. Attitude: Changes *(I,L,P,S,T,X)*: X
    (Institution/School, Learning, Person, Self, Technology,N.A.)
18. Project Administration *(F,H,M,P,R,T,V,X)*: BULLETIN BOARD
    (Facilities, Hardware & Software Mgt, Meet/Commun, Planning, Reporting, Training, Visitors, N.A.)
19. Research? *(Y,N)*: No
20. Tone *(N,O,P,NP)*: N
    (Negative, Neutral, Positive, Negative-than Positive)
21. Key Story? *(Y,N)*: No
22. Follow-up? *(Y,N)*: No

Aside:

APPENDIX D

APPENDIX E

Theme and Category Definitions

Context (C,D,H,P,S)
Classroom, District, Home, Project, School, Other

Context answers the question: Where did the episode occur? Where were the actors when the action described happened?

Sometimes one of the participants may be musing about some change or decision. It's important to record the thought even though a real action hasn't occurred. In these instances, context answers the question: What level of the project (classroom, district, home, project, school or other) would be affected?

C=Classroom—an ACOT classroom in an ACOT school
D=District—the school district to which an ACOT classroom belongs
H=Home—the home of an ACOT teacher, coordinator or student
P=Project—the ACOT project
S=School—the school that houses an ACOT classroom/s
Other—any other locale (Name it in the long box.)

Participant (A,C,R,S,T)

ACOT Staff, Coordinator, Researcher, Student, Teacher, Other

Participant answers the question: Who is/are the actor/actors described in the episode?

A=ACOT Staff—one of the members of the ACOT corporate team (does not include other Apple field or corporate staff)

C=Coordinator—the ACOT site coordinator. Each site has one. These individuals are employees of the school districts in which the ACOTs reside. (See participant appendix.)

R=Researcher—usually a university-based professor or graduate student. These persons are conducting research projects funded by the ACOT corporate staff.

S=Student—the kids of ACOT

T=Teacher—the certified teaching staff in each of the ACOT classrooms. These individuals are employees of the school districts in which the ACOTs reside.

Other—Any other person appearing as an actor in an episode. (Name type of person in the long box.)

Student Gender (M,F)

Male, Female

Gender should be used to identify the gender of the main character in the episode. If there are more participants in an episode, and they are of equal importance, enter both M and F.

Referent (H,S)
Hardware, Software

Referent answers a simple question. Does the episode focus on hardware or software? Is the speaker/sender relating problems, issues, satisfactions, or new ideas about the technology *per se*? If the episode does not focus on hardware or software, leave this field blank.

Aside from the first month of school when new equipment is arriving or not arriving, we hypothesize that staff will talk about the technology itself less and less as it becomes transparent to them and they begin to center on kids or instruction or something else. Referent gives us an easy way to track this hypothesis. We can also access repeated technology problems easily.

H=Hardware
S=Software

Instruction (C,D,E,P,T)
Content/Curriculum, Delivery, Evaluation of Instruction, Preparation, Testing, Other

This is where the serious indexing begins! Changes in any of the steps of the instructional cycle—preparation, delivery, self-evaluation, testing, then preparation—as a result of working in high access environments is one of the important areas we hope to map.

C=Content/Curriculum—the speaker/sender discusses a subject area like math, English or science. Or he/she addresses skills like

adding, writing, or measuring. Or he/she may speak of a curriculum like a reading series, or math series, or a simulation like Oregon Trail.

D=Delivery—delivery is the act of instruction. When a teacher or coordinator discusses giving kids information by lecturing, handing out assignments, or setting conditions within which kids are expected to complete a learning activity, code the episode D for Delivery.

E=Evaluation of Instruction—Be Careful! This code refers to the teacher! It should be used when the participant is discussing or reflecting on the effectiveness of something he or she may have tried or is making comments like, "next time, I'll do..."it" differently."

P=Preparation—go with your instincts. This category should be used when participants are discussing getting ready to deliver a lesson. "I spent seven hours over the week end working with a new piece of software," for example. Or "I got to school and rearranged the room so that kids could... during social studies today."

T=Testing—This refers to the kids. It should be used when kids are being tested, examined, measured, probed, but not prodded.

Other—If the episode has to do with instruction but doesn't neatly fit into any of these categories, write a word that does describe the episode in the long box.

Instructional Management (C,E,G,Q,S,W)

Climate, Environment, Grading, Quantity of Student Work, Supplies, Teacher Workload, Other

Instructional Management is a collection of responsibilities that teachers must meet to set the conditions for instruction. (This is different than preparation under the previous theme. Preparation is a one time act getting ready for a specific class or lesson.) Instructional management includes things like setting a discipline policy or creating behavioral norms; arranging the classroom for maximum efficiency or to support a general set of instructional objectives; it includes grading kids papers and recording them and writing report cards; one might hear teachers discuss ordering supplies for the coming year, managing their own time to get more done, or working out strategies to handle the increased amount of work that students deliver.

One might think about instructional management as taking care of the lower and mid-range levels of Maslow's hierarchy so that kids can operate at the higher levels. Please use the following categories for this theme.

C=Climate—this refers to the psycho-social domain of classroom life. Episodes that describe teachers efforts to create a positive atmosphere, a group feeling, a sense of family within their class should be coded C for climate.

Episodes that describe authority and/or discipline issues also fit in this category. Without some system that defines role

relationships, behavioral expectations, limits, and/or consequences for rule infractions, little quality instruction or learning occur in classrooms. Episodes that describe teacher's perennial struggles with this realm should be marked C.

E=Environment—this should be construed as the **physical layout** of the instructional setting and/or the **physical attributes** like lighting, electrical outlets, burglar alarms, etc. This category does not include the psycho-social attributes of classrooms that are frequently discussed as classroom "climate."

G=Grading—this is what it says it is, grading. This includes teachers or students marking papers, recording grades or progress in some systematic way, providing any type of evaluative feedback to students and/or their parents.

Q=Quantity of Student Work—We have seen in all of the classrooms an increase in the amount of work that students do, both in the classroom and at home. This is especially apparent in writing assignments.

Our teachers have reported from time to time that this is a new problem. They can't get around to grading all of it. "Q" should be used to code episodes where teachers or coordinators discuss this issue or suggest strategies they are implementing to deal with it.

S=Supplies—this category should be used to index episodes that deal with organizing, ordering, sharing or borrowing instructional supplies. It might also refer

to an episode where teachers muse about what else they would like to have available or discuss what they use to use and are missing now.

W=Workload—ACOT has meant difficult and time consuming work for our teachers. This category should mark those episodes where teachers decry that labor, remarking on changes in either the quality or quantity of it.

Other—If any episode relates to instructional management but doesn't quite fit any of the prearranged categories, add a word in the long box that does typify the episode.

Outcomes-Change In (A,D,E,I,P,S)

Attendance, Deportment, Engagement, Innovative Thinking, Productivity, Scores, Other

Careful! It is easy to think of this theme as relevant to students. But it could be just as relevant for teachers and coordinators if one thinks of them as learners as well. Please do!

This theme addresses change in the behaviors or other outward manifestations of the participant as a consequence of working in an ACOT environment. Changes in attitude is a separate theme (see the following theme).

A=Attendance—pretty obvious. Does the episode deal with changes in the school attendance of either students or staff?

D=Deportment—Probably a student category, but could be applied to staff. Literally, the category means, "conduct." Is the teacher

or coordinator commenting on changes in how a student or students conduct him/herself or selves as they work in the classroom or at home?

One might also imagine the teacher commenting on a change in his/her own behavior as a teacher. In either case, use the big, big "D."

E=Engagement—Staff remark about how kids work for long periods of time at the computer, seemingly intent, focused, and productive at some task (this is not always engagement on an assigned learning task). Further, they remark about how they themselves get involved and suddenly discover that a whole afternoon has passed by as they are working on some project for their classroom. We are indexing these kind of comments under engagement. Use "E."

I=Innovative Thinking—This, too, requires the description of an outward change in behavior, even if the behavior is someone describing how he or she is thinking about solving some problem or situation. Look for it in episodes about both kids and staff.

P=Productivity—This is going to get confused with "Q" under Instructional Management, just watch! In this case "P" should mark episodes where teachers or students are described as able to expand their control over the work that they do, either the number of tasks they are able to accomplish, or the number or quantity of assignments within some task.

Remember that "Q" refers to the **management** of this productivity.

S=Scores—This is a student category that should be used exclusively to tag episodes dealing with changes in students' scores on achievement tests or other measures of student work.

Other—Anything else having to do with change in student or teacher output that doesn't fit in one or more of the subcategories. Name a new category in the long box.)

Attitude-Change In (I,L,P,S,T)

Institution/School, Learning, Person, Self, Technology, Other

This theme deals with changes in individual's beliefs of "attitudes" about him or herself or other factors related to their school experience.

I=Institution/School—changes in attitude towards schooling as an institution or any subset such as district, school, or classroom.

L=Learning—expressed changes in attitudes about learning or about one's ability to learn.

P=Person—changes in attitude towards others.

S=Self—changes in attitude towards oneself, not having to do with one's perceived ability or inability to learn.

T=Technology—this category should mark episodes in which participants comment on their own changing beliefs or attitudes towards technology in any of its many manifestations.

Other—any episodes that deal with changes in attitude but do not fit with any of the previous attitude categories. Name a new category in the long box.

Project Administration (F,H,M,R,T,V)
Facilities, Hardware & Software Mgt., Meetings/Communication, Reporting, Training, Visitors, Other

ACOT's site coordinators prepare weekly AppleLinks and discuss many of the tasks that they accomplish which have little to do with technology, learning, teaching, or research. Many of these activities will fit one of the categories listed under Project Administration. In general such episodes will have to do with allocation of resources, scheduling, making reports, training, or attending meetings. These tasks are essential to the well-being of the project. It is important to track how much administration and what kinds are required by innovative technology projects--it's part of the overhead of change in schools. We need to understand it.

Don't confuse this category with instructional management. IM activities provide the scaffolding for lessons and learning. Project Administration activities scaffold the entity we call ACOT.

F=Facilities—tag episodes with "F" that relate planning and implementing physical, structural, or space changes that are required to house an ACOT classroom within a school. This would also include

ordering furniture, phone-lines, changing wiring, etc.

H=hardware & Software—this tag is for episodes that describe ordering, purchasing, maintenance arrangements, storing, etc. Again, think administration not instruction.

M=Meetings/Communication—ACOT field staff spend a lot of time communicating by phone or face to face in meetings with software and hardware vendors, school district personnel, university people, or ACOT corporate staff. Frequently, these are planning and/or coordination meetings, preparing the way for contract preparation, new research studies or some other major event like AppleFest. Tag descriptions of such events "M."

R=Reporting—ACOT requires various forms of reports to be submitted from the districts to mark progress at the sites or to provide feedback about the effectiveness or ineffectiveness of some process or product. Also software vendors who contribute programs to the sites, the district to which the ACOT class belongs, even state or federal agencies sometimes request various verbal or written reports. Tag such episodes with an "R."

T=Training—this category includes episodes that describe or reflect on opportunities staff have had to learn and apply something new. Training! It starts with a "T."

V=Visitors—Sometimes considered the scourge of the sites, visitors seeking information

about life in ACOT are frequently on the scene. "V" should be used to tag episodes about the administration of time and presentations to such occasional guests.

Other—If it has to do with administration and it's not contained in other categories, write a descriptor in the long box.)